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INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

S-E-C-R-E-T

50X1-HUM

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SUBJECT	Notes on Soviet-East German Aviation Technicians' Discussion of Precision Casting Techniques	DATE DISTR.	7 May 1959
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SOURCE EVALUATIONS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

A theoretical discussion of the following items was held: pressing dies for patterns, investment-casting patterns, refractory coatings, investment and melting-out, melting and casting, testing the casting, and heat treatment.

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Item 1: Pressing Dies for Patterns

In general, steel dies are used, but also aluminum alloy dies, which have withstood several thousand pressings. No master blades 50X1-HUM /patterns/ are produced; rather, the corrected aluminum mold is used as a copying pattern for the steel die to be used in the final series. They reject the use of master patterns, because it would double the errors.

Soft metal dies, the surfaces of which are chromium plated, are used only in the light industry. Shrinkage value generally 1.4% for all alloys (Л К4, Ж S 3, В Л 7 - 45 Ch).

Final correction done according to the results of the first castings. The machining allowance amounts to + 0.1 to + 0.2 mm per surface. Smaller machining allowances are not good, since the blades are machined on all sides.

Item 2: Investment-Casting Patterns (Ausschmelzmodelle)

As described in Instruction 550, the material used for the pattern is preferably colophony, polystyrene and ceresin. The latter is a hard material with a high softening point, thus there are no special requirements for the temperature in the pattern shop (Modellraum). Up to 50% recovered investment compound can be added to the pattern mass for new patterns. Two methods are used to fill the molds:

1. with a poured-off measure of liquid wax and subsequent pressing of the wax for about one minute;
2. with a wax spraying machine operating at a pressure of 5-10 atmospheres gauge and removal of the wax pattern after 13-20 seconds.

Three pressed molds, stretched on a wire-gauge table, are used. Each step lasts about 20 seconds. It was suggested [redacted] 50X1-HUM research on hollow plastic patterns since the plastics industry in East Germany is very highly developed.

The gating practice is about the same as in ordinary foundry work, i.e., the ratio of gate: flow-channel: sprue = 2 : 3 : 4. Bottom casting is not recommended.

Item 3. Refractory Coatings

The coating materials ("Marschallit" = marshite = finely ground quartz) used are those specified in the instruction.

Analysis of marshite: SiO_2 = 98.0%
CaO = 1.0% approximately
Al_2O_3 and MgO = 1.0% approximately
100.0

In the prehydrolysis the total amount of water is added along with the usual amounts of ethyl silicate, alcohol and hydrochloric acid. After 24 hours, the fillers, SiO_2 and Al_2O_3, are added. A check is made on the coating material by dipping a wax blade into the coating material to be tested, and allowing it to dry (without sprinkling sand). In the case of the formation of cracks in the coating, the hydrolyzed ethyl silicate is not released for the operation. The acceptance test for the ethyl silicates is a SiO_2 analysis and a boiling analysis. The latter test is only for uniformity; no specific determinations are made. If the deviations are rather large, the material is not used after changing the additives, but is rejected for delivery. The originally (in the instruction) wide tolerance for the HCl content has now been narrowed, allegedly to 0.6%. An air-conditioned room with a temperature of 20 deg Cent is recommended as a drying room. If the humidity of the room is too low, the drying process is too rapid.

Item 4. Investment, Melting-Out, Heating

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Investment is done in the wet state, in accordance with the instruction; no dry mold-facing material (Hinterfuellung) is used. The melting out and annealing is done in a 4-zone furnace. The melting-out temperature is 160 deg Cent; the annealing temperature is 900-950 deg Cent. The molds are cleaned of dust and foreign particles before the pouring-out.

Item 5. Melting and Casting

A high-frequency furnace with a 75-100 kg capacity is used for the melting; the generator output is 100-150 kw. Alloy ~~X~~ S 3 should be worked only in small 10-kg tilting furnaces. As specified by the instructions, the crucible materials consist of magnesite or chromium magnesite (Chrommagnesit). The crucibles are rammed up and heated within the induction coil. The induction coil itself is washed (eingeschlaemmt) with a mixture of Al_2O_3, water glass or ethyl silicate as a binder. The drying time for the crucible, at 150-180 deg Cent, is 2-3 hours; this is followed by a slow heating up to the melting temperature of the invested steel or cast iron for a period of 3-4 hours, followed by a slow cooling.

Lifrenko [redacted] ten years ago, cast 10 charges with such a crucible, which corresponds to about 1,000 kg, without damage to the crucible. The melting temperatures are checked with optical pyrometers. 50X1-HUM

Circulating material (Kreislaufmaterial) is placed into a 100 kg crucible and heated to about 1,800 deg Cent, or at least 1,750 deg Cent, for the purpose of deoxidation. A violent reaction (boiling) begins in the bath.

When the boiling begins, the current is cut off. Limestone flux or calcium oxide are used as slag additives.

The reaction takes place when the chromium oxide reacts with the carbon of the melt, and CO gas is given off. The other oxides react the same (compare Bessemer process). Finally, at the completion of the reaction, the crucible contents are poured into pigs at 1,500 - 1,600 deg Cent. A pronounced decrease of carbon takes place in the alloy.

For the castings, 50 percent new material is added to these pigs in smaller furnaces (25 kg). At 1,680 deg Cent, deoxidation is carried out with CaSi, CrB, CrAl, or metallic Si.

Limestone flux and calcium oxide are added as slag.

The pouring temperature is 1,580 - 1,600 deg Cent. The molds are at a temperature of 900 deg Cent, or 950 deg Cent with very small cross sections.

For Ж S 3 and B Л 7 - 45 Y the same applies, with respect to the treatment of the circulation material.

Alloy Ж S 3, however, is melted in 8 kg tilting furnaces in 5-8 minutes without slag and poured into the warm mold on the furnace. The ordinary Л K - 4 method does not work in the case Ж S 3, because of its high aluminum content. No vacuum has been used up until now. The use of an argon protective atmosphere produced no better results.

In the case of B Л 7 - 45 Y, special ferrotungsten containing no Pb, Sn and Sb is used. No experience has been had with centrifugal casting. NiB is added for the purpose of reducing the grain size; thus 0.01 - 0.02% B is contained in the preliminary alloy. NiB contains 7-10% B. If the melt contains aluminum, the burning off of B is unimportant. In the case of B Л 7 - 45 Y, NiB is also added to the casting material, whereby the boron content is computed according to the amount of new material added.

Item 6. Testing the Casting

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The profile dimensions are checked on three cross sections by means of templates. Every wax pattern and every casting is tested. Measurements of these parts can also be made with light beam scanning and projection. In practice, only templates are used.

There are no specifications regarding the surface quality of the raw products, since they are all slated for machining. Of course, no faults can be present which might possibly effect the quality of the finished part. The admissibility of faults in the finished parts depends on teststand experience. No faults are permitted along the edges; on the other hand, pores of up to 1 mm Ø and 0.5 mm depth [are allowed] on the faces. Checking is done with calibrated standards. The final decision in regard to blades rejected on the basis of calibrated standards is up to the chief metallurgist.

Most rejects result from inadmissible size deviations, and very seldom because of too low mechanical properties. Impurities, oxide skins and slag inclusions can also cause rejects. A reject figure of 20% is considered good for a series operation in the foundry. Rejects of ЛК - 4 and В Л 7 - 45 Y are generally more numerous than for ЖС 3.

The following materials tests are made:

10% x-ray tests

100% etching tests for oxide skins, etc., which are revealed as extensive grain boundaries.

The toughness test (Festigkeitsnachweis) is carried out on every charge, not for every melt. No fatigue tests (Zeitstandversuche) are made; no grain size specifications are in force.

Item 7. Heat Treatment

For ЖК 4 only an annealing for 3-4 hours at 790-800 deg Cent is proscribed for the purpose of stress relief.

Items 8 and 9. -

Various Additional Questions

1. Method of cutting out specimen rods

Specimen rods are melted as a cross of four pieces, either alone or together with a cluster of blades (Schaufeltraube). The mechanical working is done after the heat treatment. The specimen rods can also be worked out of the gate or sprue (Einguss), but this is not recommended. After being separated, the specimen rods are machined by means of carbide cutters. The pouring of individual specimen rods is not recommended because of the danger of inclusions and oxide skins.

2. Straightening the Blades

The blades are heated to 700-900 deg Cent and straightened in a die. The form of the die is determined through practical experiments. At the place to be straightened, there must be a plastic deformation, thus corresponding shims are used. The alloy ЖК 4 and B ЖС 7 - 45 Y are easy to straighten, but ЖС 3 is difficult to straighten.

In the final discussion, the Soviets promised to submit via the Moscow office:

1. The standards for ЖК 4, ЖС 3 and B ЖС 7 - 45 Y
2. The standard for ethyl silicate
3. The standard for P 24
4. Normal chip of ЖС 3 with analysis
5. Sketch of the specimen form for temperature change test.

The colleagues at the Soviet ministry asked us for the following data:

1. technology for the chemical treatment (etching) of steel and castings;

2. specifications for sulfiding with data on what layer thickness is produced;

3. technology for the heat treatment of P 18 and a series of photomicrographs showing admissible and inadmissible polished sections with respect to overheating and martensite formation;

4. technology for casting teflon around bronze parts for shielding;

5. sample of our material for patterns for testing by them.

To the wuestion of what grain sizes are admissible in forgings of EI 617 and EI 435 B, the reporter remarked that a special danger was the lack of uniformity of grain size. Grain sizes up to 2 mm are admissible for blades, and up to 3 mm for slides.

At the end of the talks the Soviets expressed interest in a further exchange of experiences.

Moscow, 3 June 1958

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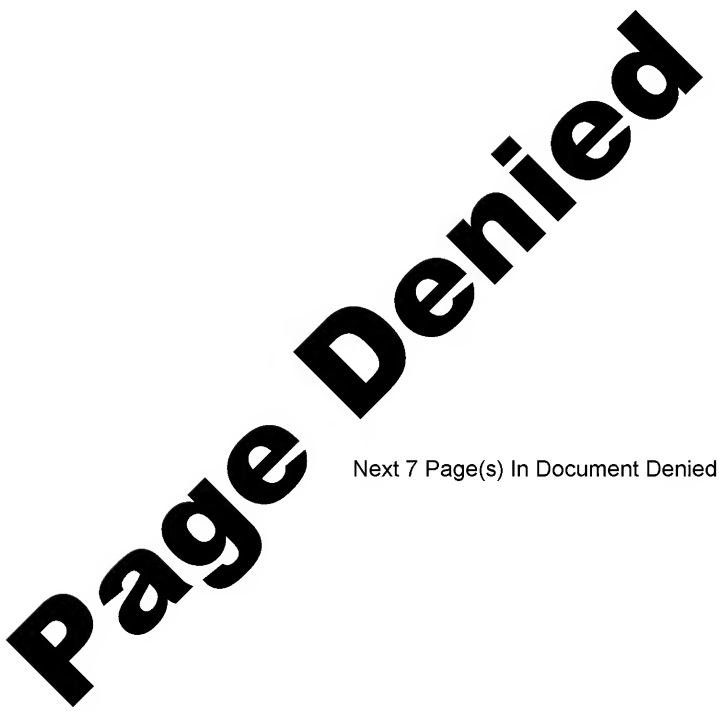

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